the Global Oscanner
a quarterly newsletter from the GES DAAC
Spring 2000 ⁂ Volume 1 ⁂ Number 4

SeaWiFS and Ocean Color

by James Acker with Lee Kyle

Remote sensing of ocean color from space provides information on the abundance of phytoplankton and the concentration of dissolved and particulate material in surface ocean waters. This information can be used to investigate biological productivity in the oceans, marine optical properties, interaction of winds and currents with ocean biology, and how natural climate variations and human activities influence the oceanic environment. The Goddard Earth Science (GES) Distributed Active Archive Center (DAAC) provides access to data from the two ocean color sensors currently in operation and from historical data sets. This article sketches the history of the Sea Viewing Wide Field-of-View Sensor (SeaWiFS) ocean color data sets at the GES DAAC.

SeaWiFS was originally conceived during the latter part of the 8-year Coastal Zone Color Scanner (CZCS) mission, which took place from October 1978 to June 1986. CZCS demonstrated the feasibility and usefulness of obtaining ocean color data from a satellite sensor. SeaWiFS was conceived as the next mission, an instrument with improved optics that would carry out full-time observations of Earth. CZCS was an instrument on the Nimbus–7 satellite that also carried other remote sensing instruments. Those instruments shared the limited power available from the satellite's solar panels, which was insufficient to operate all the instruments all the time; thus, CZCS was operated only part time. SeaWiFS is the only scientific instrument on the Orbview–2 spacecraft, and it operates full time.

Though SeaWiFS was conceived in the 1980s, it took several years to obtain funding for the mission. SeaWiFS was made possible by a unique partnership with a private company, Orbital Sciences Corporation (OSC). OSC later created Orbimage, Inc., as an auxiliary business for remote sensing data. NASA specified the necessary data quality for the instrument then allowed OSC to come up with a design and a launch vehicle for the mission. In return, OSC was allowed to sell the data for commercial applications, such as for fisheries or for military use. NASA specified a cost for the mission's data that they would pay if the mission were successful. Thus, SeaWiFS is called a "data buy" mission.

OSC collaborated with the Santa Barbara Research Center (SBRC) to design and build SeaWiFS. The basic design uses a rotating mirror that scans Earth repeatedly as the satellite passes (SeaWiFS moves from north to south on Earth's lighted side, and from south to north on its dark side, which is called a "descending node" orbit). Each rotation of the mirror provides one scan line of data. The light from the mirror is reflected through filters (called "spectral bands" or simply "bands") and then onto a light detector that measures the intensity of the light. The speed and altitude of the satellite, the rotation speed of the mirror, and the size of the detector elements determine the resolution of features on Earth's surface. Resolution is the size of a picture element, or pixel, on the surface. The best resolution SeaWiFS achieves is 1 km directly below the satellite (at "nadir"). The area that each scan line covers is 2800 km, but the best data are in the middle 1500 km of the line because of the curvature of the planet.

SeaWiFS launched August 1, 1997, on a Pegasus XL rocket. Pegasus rockets are carried to about 30,000 feet by a plane then dropped as the rocket engine fires and takes the satellite into

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space. The SeaWiFS satellite was maneuvered into the proper Sun synchronous orbit. In this orbit the satellite always views a given location at the same local time. Full-time data acquisition began September 18, 1997.

SeaWiFS has eight bands in the visible and near-infrared light range. The visible bands provide the main remote sensing data from the satellite, while the near-infrared bands are used for atmospheric correction. SeaWiFS measures a quantity called "water leaving radiance," light from the Sun that has been scattered and absorbed in the ocean then bounced back toward space.

The SeaWiFS mission was designed to do something that CZCS could not do, which is to provide global coverage of the oceans on a regular basis. The orbit and scan line width of SeaWiFS allow the instrument to observe about 90 percent of Earth's surface every 2 days. On a particular satellite pass it is not possible to see much of the actual surface because of clouds, but for longer periods of time the data can be analyzed so that the obscuration caused by clouds is negated by the repeated views obtained of the same area. The satellite broadcasts the data it receives immediately, and this signal can be picked up by any ground station close enough to the satellite to receive it. The ground stations are called High Resolution Picture Transmission (HRPT) stations. HRPT station data, also called Local Area Coverage (LAC) data, are the highest resolution data that can be obtained from SeaWiFS, because the satellite broadcasts all of the data it receives.

Onboard the satellite, a computer "samples" the data, the outer ends of the scan line are eliminated, and then every fourth pixel is recorded. These data, called Global Area Coverage (GAC) data, have an effective resolution of 4.5 km and are stored on the computer until it passes over Goddard Space Flight Center in Maryland and the Wallops Flight Facility in Virginia, either at noon or midnight. All of the GAC data are transmitted at once at those times. (Orbimage Inc., located in Virginia, also receives data at those times from the satellite and from HRPT stations. Orbimage and the SeaWiFS Project collaborate to control the satellite functions through the Mission Operations Facility.)

Once received, either from the satellite or from the ground stations, the SeaWiFS data processing facility begins to process the data. They are checked for navigation accuracy to make sure the Earth location of the data is precise. Then the scientific algorithms created by the SeaWiFS Project and oceanographers around the world (the SeaWiFS Science Team) are applied. The first thing the algorithms do is remove the influence of light scattering in the atmosphere (atmospheric correction) using data from the near-infrared bands. The data are also corrected for the angle of the Sun. Ancillary data, including water vapor and ozone in the atmosphere, are also used in these algorithms. The algorithms are applied to the data to calculate important oceanographic quantities, such as the concentration of chlorophyll or the depth that light penetrates into the ocean.

The next process performed by the data processing facility is the creation of global data products. The 4.5 km data are combined and averaged (a process called "binning") for periods of 1 day, 8 days, a month, and a year to provide images of Earth with a resolution of about 9 km. As the binning period becomes longer, the influence of clouds is reduced because the data used in the global products are only Earth surface data. Because clouds move, over time SeaWiFS will get a view of almost every place on Earth's surface. So the annual SeaWiFS images show most of Earth without clouds. Once the data have been processed, they are tested by the Calibration and Validation process.

Calibration is designed to ensure that the light levels the instrument measures remain accurate. Because exposure to the harsh environment of space over time will cause the optics in the instrument to degrade, SeaWiFS uses several methods, including viewing the Moon, to monitor the accuracy of the instrument. Necessary calibration corrections are applied to the data.

Validation refers to the process of checking the calculated data against data obtained by researchers at Earth's surface (in situ, ground truth, or sea truth data). Researchers determine the concentration of chlorophyll in the ocean, or measure the water-leaving radiance right at the ocean surface. A light-sensing buoy in the ocean near Hawaii also sends back data that can be compared to the satellite data.

When the data are ready, they are sent to the GES DAAC. There the Ocean Color Data Support Team (OCDST) stores the data in duplicate libraries so that they will not be lost. The OCDST, led by James Acker, also helps researchers obtain SeaWiFS data and documentation from the archive for use in their own oceanographic research.

Reprocessing #3

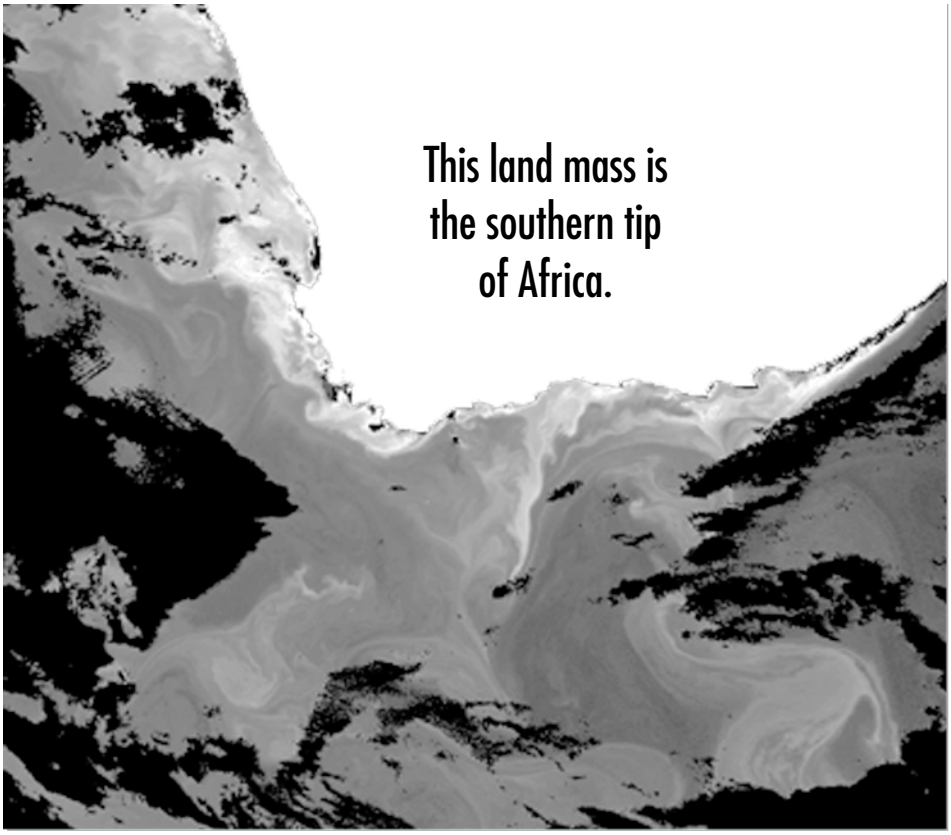
From time to time the SeaWiFS Science Team, led by Dr. Charles McClain, introduces algorithm changes to improve the quality of the SeaWiFS products. When this is done, the old SeaWiFS data are reprocessed to make them consistent with the new measure-

ments. Previous algorithm changes and reprocessings occurred in January and August 1998. The third reprocessing effort started this May (2000). Numerous improvements have been introduced throughout the processing algorithms from the calibration to the chlorophyll determination equation. Also, a few products were deleted and others added. The Science Team placed extensive documentation of the changes on the Web (see the Third Reprocessing URL below). Present SeaWiFS users are urged to consult it.

Ocean Color Data at the GES DAAC

Ocean color and chlorophyll products from SeaWiFS are available from September 1997 on, with about a month's delay after the actual observations. GAC data are available with a 4 km resolution for the sensor measurements and derived science products, but the gridded science products have a 9 km resolution. One-km resolution LAC data are also available. The NASA SeaWiFS data set is a data purchase form Orbital Science Corporation and comes with certain restrictions. To obtain these data, potential users must register and submit a summary research proposal. They must also sign an agreement not to share the SeaWiFS data they obtain with any nonregistered scientists. All members of a study team should register, not just the principal investigator. Registration details are available through the GES DAAC Home Page. The first 5 months of SeaWiFS data and all 8 years (10/1978–06/1986) of CZCS ocean color data are available on an unrestricted basis. In the near future, ocean color products from the MODIS instrument on the Terra satellite will also be available (see the MODIS article on p. 6). While different GES DAAC teams will handle the SeaWiFS and MODIS ocean color data, customers will find both conveniently available.

In addition to ocean color data products and documentation, the GES DAAC Ocean Color Web site offers ocean color educational material and several "Science Focus" scenes. Science Focus is a collection of SeaWiFS scenes of notable events and eye-catching images observed by the SeaWiFS instrument. An interesting example is the scene "Clear Day Over the Agulhas." Readers are encouraged to go on line and view the other Science Focus scenes and also the educational material.



This grayscale image of the Agulhas oceanic region at Africa's southern tip shows details of the region's complex current interactions. Because these SeaWiFS data are at a resolution of 1 km, several small circulation features can be observed. Observational data of this kind can be combined with models of oceanic circulation to refine our understanding of how the large-scale movement of seawater influences the populations of microscopic phytoplankton and tiny zooplankton in the ocean (chlorophyll range in mg/m^2: black=0.01, white=64.0).

— from the GES DAAC Ocean Color Web site —

Recommended Web Sites

GES DAAC Ocean Color Web Site
http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/OB_main.html

Ocean Color Educational Resources
http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/OB_Education.html

Ocean Color Science Focus
http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/science_focus.html

SeaWiFS Project Home Page
http://seawifs.gsfc.nasa.gov/SEAWIFS.html

Third Reprocessing
http://seawifs.gsfc.nasa.gov/SEAWIFS/RECAL/Repro3/

Partners

by
Lee Kyle,
Steve Kempler,
Long Pham, &
Monica Myers

The GES DAAC puts a great deal of effort into helping its customers make optimal use of its archived data. Data support partnerships serve as important means for facilitating the use of GES DAAC data in specific fields of study and improving the accessibility of local and remote data sets. Partnerships provide an inclusive perspective on customer needs, desires, and plans. This is mutually beneficial, as it allows the GES DAAC to more efficiently provide data and information to the partners and other customers doing similar work. In turn, this allows these customers to carry out their research and projects more expeditiously and often at less expense. This article summarizes some of these partnership activities, with emphasis on a group partnership known as the ESIP (Earth Science Information Partnership) Federation and on a project to predict outbreaks of certain tropical infectious diseases. References are given for those interested in more indepth discussion.

The ESIP Federation

The goal of NASA's Earth Science Enterprise (ESE), is to further develop an understanding of the total Earth system, including the effects of natural and human-induced changes to the global environment. This includes collecting global data and sponsoring the analysis and interpretation of global and regional environments. To further this goal NASA has sponsored an ESIP Federation experiment based on a 1995 National Research Council recommendation for the formation of a federation of Earth science partners. The ESIP Federation brings together 33 partners. Nine are NASA sponsored data archives (DAACs) that are termed Category 1 ESIPs. Through a competitive competition NASA selected 24 additional teams. Twelve are Category 2 ESIPs that combine Earth science studies with the development of ways to make Earth science data more useful to the user community. The twelve Category 3 ESIPs specialize in producing information products and services suitable for users beyond the Earth science research community. These include applications in agriculture, coastal and marine uses, education and public outreach, and one in legal information.

The ESIP Federation is thus a mixture of Earth science data providers, researchers, and public service providers. It is self governing and has set up interest clusters to concentrate on important areas. This helps the federation become more than a mere aggregate of individual units. In step with this, the GES DAAC has become active on several levels. In its role as a data archive it is a Category 1 ESIP. It is also an active member of several federation interest group clusters and a partner in the Category 2 Seasonal and Interannual Earth Science Information Partnership (SIESIP). The GES DAAC is presently active in three federation clusters where the members cooperate in addressing questions of common interest.

- Hydrology
- LBA (Large-Scale Biosphere-Atmosphere Experiment in Amazonia)
- Technology & interoperability with emphasis on DODS (Distributed Oceanographic Data System).

The GES DAAC's responsibility for the Tropical Rain Mapping Mission (TRMM) data set makes it an important player in the Hydrology cluster, while LBA can be considered as a subset of Hydrology. The GES DAAC's participation in these two clusters assists both the collection of valuable data and the subsequent access to the data from the GES DAAC and numerous other archive centers. The technology and interoperability problem is continuing and ongoing with all the DAACs because of the rapid increase in the volume of data they are handling combined with the equally rapid changes in computer and communication technologies. The GES DAAC's numerous data holdings also make it a natural SIESIP partner. All of these activities make the GES DAAC a better and more efficient data provider.

SIESIP

SIESIP is a consortium formed to address the research needs of those working on the important seasonal and interannual variability and predictability problem. A principle purpose of SIESIP is to make a large suite of seasonal and interannual data sets (both NASA and non-NASA) easily available to the entire scientific community. The SIESIP partners are George Mason University (GMU), the University of Delaware, the Center for Ocean-Land-Atmosphere Studies, and the GES DAAC. It is led by Professor Menas Kafatos of GMU and has an advisory board consisting of notable research scientists and information technologists. The consortium pools their scientific, data, and technical resources to better serve the science community.

With the active support of the GES DAAC, the SIESIP consortium has accomplished several goals including

- Linking university, research organization, and GES DAAC data sets and allowing searches and orders at member universities in addition to the GES DAAC. Aiding in the production of new or longer data sets.

- Planning and producing climate data CDs to meet research and university needs. Example: the *Climatology Interdisciplinary Data Collection.*
- If feasible, putting climate parameters on uniform temporal and spatial scales. This is useful for interdisciplinary scientists and graduate students and sometimes also aids discipline researchers.
- Improving and distributing the internationally known and used Grid Analysis and Display System (GrADS) scientific analysis tool. This is being adapted to support more data types and data formats.
- Improving the ease of use of SIESIP data by making it accessible by DODS and adding GrADS to the DODS suite of client software. GrADS has also been adapted to act as part of the DODS server to manipulate data prior to transfer and to allow DODS to more easily support additional data types and formats. Both DODS and GrADS are available without charge.

DODS

DODS is a software system that was designed for widely separated research groups using disparate data formats who wish to interchange and analyze each other's data with a minimum of difficulty. Designed by a joint University of Rhode Island and MIT team, it was chosen as a Category 2 ESIP as a way to facilitate data exchanges within the federation and among the scientific community at large. DODS follows the client-server model: a DODS server is installed at the data archive; servers are available for several computer platforms and several data formats; customers download DODS client software with which to access the data. The client application sends a data request across the Internet to a server that answers with the requested data. The server retrieves data from particular data sets. Several data display and analysis programs have been adapted to operate as part of the DODS client program. These include MATLAB, IDL and the free analysis packages Ferret and GrADS. In the DODS client environment, the investigator can call up a table of available data sets on all DODS servers and order the desired portions of any of them. The data are delivered via the Internet and can be promptly viewed and analyzed by the analysis packages.

Long Pham has been in charge of installing the DODS server at the GES DAAC to handle some of our data sets including our TOMS ozone measurements and some TRMM products. These will start being available through DODS in June. The GES DAAC is focusing on two server formats, HDF and FreeForm. Since HDF has been used extensively in the scientific communities, this format is the easiest to serve. FreeForm will be used for data formats that are not widely used. With FreeForm, you will need to describe your data format in a separate file. Using these two formats, the GES DAAC will be able to serve most of its data. Metadata for selected GES DAAC data sets are being compiled and will be inserted into the DODS data catalog file. From this file customers using a DODS client will be able to select the data files from the DODS data catalog that they want. The work required to set up the catalog file will vary from archive to archive. Most customers should find it simple and straightforward to download, install, and use the DODS client programs.

International Research Partnership for Infectious Disease (IntRePID)

IntRePID is another partnership in which the GES DAAC participates. This is an international research team organized in 1996 to develop early warning systems (EWS) to predict global disease outbreaks caused by arthropod borne viruses. It is managed by Monica Myers and Chris Lynnes of the GES DAAC. The first disease identified for EWS target development is dengue, which is spread by mosquitos. According to the World Health Organization this disease is rampant in more than 100 countries and territories in tropical and subtropical regions including areas in Asia, Africa, and the Americas. The annual incidence of the disease is gauged to be in the tens of millions with an estimated 500,000 cases hospitalized each year and 24,000 dead. The IntRePID group thinks the system they are constructing will give authorities in developing economies with scant resources about 2 months warning of impending epidemics.

The project consists of setting up a global online dengue surveillance system, developing dengue outbreak prediction models, and finally collecting the input data, running the models, and sending out the dengue early warnings. Dr. Antoine Flahault of France is in charge of the dengue surveillance element. He has experience handling incidence maps for influenza and other diseases. Oxford and Johns Hopkins Universities are designing the dengue outbreak prediction models. The GES DAAC will be in charge of ingesting the disease and environmental data and running the models. The dengue surveillance and outbreak prediction models are in the final development stages. The initial study site for model development is Bangkok, Thailand, which has a 35-year dengue data set. Using this information, the model makes predictions based on elevation, population density per km^2 and a variety of Fourier processed, multitemporal imagery from the NOAA AVHRR measurements. Satellite temperature measurements are particularly important. This model has also been used to make dengue predictions for all of Thailand. The models are being expanded to treat all tropical and subtropical regions. It is also planned to incorporate environmental observations form other satellite instruments to enhance the model predictions.

The data flow within the Global Change Data Center will be automated by a simple, scalable, script based sci-

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MODIS L1 Data & L1 Direct Broadcast Now Available

by Lee Kyle

— with notes from Chris Lynnes —

The MODIS instrument on the Terra satellite is recording scientific measurements of the Earth-Atmosphere system on a full-time basis, but its calibration and science product algorithms are still being evaluated and adjusted by the MODIS team. A preliminary version of the L1 products, which include calibrated, Earth located radiances, are now available to the public from the GES DAAC. All the data files are in HDF-EOS format. A preliminary Direct Broadcast version of the L1 software has been developed and is being improved. However, since a number of calibration issues are still being worked on, the present data are principally being used by researchers to evaluate algorithms designed to produce higher level science products. The MODIS Calibration Team anticipates that most of the present calibration problems will be resolved by July.

The Terra satellite was successfully launched December 18, 1999. Following a checkout period, it reached operating orbit on February 23, 2000. The following day, February 24, the MODIS nadir door was opened to give the instrument its first view of Earth. Some sensor and calibration adjustments were subsequently made, and the MODIS data now available to the public starts on day 78 (March 18) of the year 2000. The MODIS Science Team is still reviewing the quality of the earlier data.

The MODIS Science Team is responsible for creating the algorithms that transform the measurements into useful science products and assessing the accuracy of these products. It consists of 28 members from the United States, United Kingdom, Australia, and France. The team leader is Dr. Vincent Salomonson of the Goddard Space Flight Center (GSFC). The team is divided into four discipline groups: Atmosphere, Calibration, Land, and Ocean. The Calibration group is led by Kurt Thome of the University of Arizona at Tucson and is supported by the MODIS Characterization Support Team (MCST) at GSFC. The GES DAAC will handle the Atmosphere and Ocean products and the calibrated geolocated radiances, and our MODIS Web site will keep the public posted regarding availability of the various products and their quality. Additional information may be obtained from the MODIS Web site. The MCST Web site gives the detailed status of the MODIS calibration (see References).

L1 Processing Software

On April 28 the Direct Broadcast component of the Terra satellite was turned on. During most of the satellite orbit the Direct Broadcast component transmits data in real time to stations within a line of sight of the satellite as it passes overhead. This allows properly equipped centers to obtain local area data faster than they could from the DAACs. GSFC is working on software to produce, calibrate, and geolocate radiances from these real-time transmissions. Current plans call for the Direct Broadcast to be on full time except when it is passing over one of NASAs Deep Space Network antennas when they are actively tracking a remote spacecraft. It is estimated that this will occur less than 2 hours per day. Two GSFC organizations, the GES DAAC and the Applied Information Sciences Branch, are working together to produce this software package.

The signal is first processed in hardware then in software to produce Level 0 files called Production Data Sets, which are in a packed, 12-bit CCSDS-based format. The Level 1A algorithm reformats those into HDF files. The geolocation algorithm extracts orbit and attitude from the Level 1A files to produce a geolocation product, also in HDF. The Level 1B calibration algorithm then uses both the geolocation and the Level 1A product to produce calibrated geolocated radiances. All of these algorithms are virtually identical to the GES DAAC's production algorithms, with adaptations to Direct Broadcast.

The Applied Information Sciences Branch has developed the capability to receive and process the signal to Level 0. Information, data, and software for Level 0 processing can be obtained from their site. At the GES DAAC Chris Lynnes, Peter Smith, and Larry Shotland adapted Level 1A and 1B processing software to handle the Direct Broadcast Level 0 data files.

References

MODIS data and information from the GES DAAC (geolocated calibrated radiances plus atmospheric and ocean products)

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/MODIS/index.html

MODIS (Terra) Direct Broadcast L1 processing information

http://daac.gsfc.nasa.gov/DAAC_DOCS/direct_broadcast/db.html

MODIS (Terra) Direct Broadcast Image

http://daac.gsfc.nasa.gov/DAAC_DOCS/direct_broadcast/db_pix.html

MODIS (Terra) Direct Broadcast L0 processing information

http://sdcd.gsfc.nasa.gov/ISTO/dro/eos/doc.html

MODIS recent Direct Broadcast scene picked up at Goddard

http://earthobservatory.nasa.gov/MissionControl/Terra/ModisDB/

Terra satellite data from ASTER, CERES, MISR, MODIS, & MOPPIT

http://eosdatainfo.gsfc.nasa.gov/eosdata/terra/data_access.html

MODIS Characterization Support Team

http://mcstweb.gsfc.nasa.gov/index.html

MODIS Home Page (includes information about the science team and much more)

http://modis.gsfc.nasa.gov/MODIS/

The MODIS Image gallery can be reached from this page by clicking on **Images** under **About MODIS** or by going directly to

http://modis.gsfc.nasa.gov/cgi-bin/texis/MODIS/IMAGE_GALLERY/modimgview

Earth Observatory

http://earthobservatory.nasa.gov/

The Terra Satellite

http://terra.nasa.gov/

Partners
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ence processor designed by Chris Lynnes. It is a set of Perl scripts to run the prediction models automatically when all necessary input data are available. It also includes a Web based program allowing operators to monitor the processing.

IntRePID partners include NASA; the Department of Defense, Agency for International Development; the State Department; the U.S. Department of Agriculture, Center for Disease Control and Prevention; (French) Institute for Medical Research and Health; and the Universities of Oxford, Johns Hopkins, and Michigan. The project is funded by the Innovation Fund Committee of the National Performance Review and NASA's Earth Science Enterprise division of Applications, Commercialization, and Education.

The IntRePID partners have also started work on a malaria early warning system that will be particularly useful in Africa where malaria kills approximately 1 million children per year.

Future articles will discuss other GES DAAC partnerships including technology collaborations.

Recommended URLs

SIESIP Home Page

http://www.siesip.gmu.edu/

DODS—Distributed Oceanographic Data System

http://www.unidata.ucar.edu/packages/dods/

ESIP Federation Home Page

http://www.esipfed.org/

Earth Science Enterprise (ESE)

http://www.earth.nasa.gov/

The Science of the Earth System

http://www.earth.nasa.gov/science/index.html

FluNet

http://oms.b3e.jussieu.fr/flunet

GrADS—Grid Analysis and Display System

http://grads.iges.org/grads/

GES DAAC News

New Data Products

General News

People in the News

— as reported by George Serafino and the Customer Support Teams —

DATA PRODUCTS AND SERVICES

ATMOSPHERIC CHEMISTRY

Ozone and other trace gas compositions, dynamics, and energy interactions of the upper atmosphere.

New TOMS CD-ROM

The Atmospheric Chemistry and Dynamics Group (NASA GSFC Code 916) is in the process of putting the finishing touches on a new CD-ROM for the EP TOMS instrument. It will cover the years 1996 through 1999 and feature the following items.

- Daily aerosol index and total ozone for the globe
- Monthly aerosol index and total ozone for the globe
- Zonally averaged total ozone for both daily and monthly data
- Overpass total ozone data for 457 distinct locations on Earth
- Daily and monthly-averaged GIF images of aerosol index and ozone
- Information on trends, ozone hole monitoring, and calibration
- Comprehensive EP TOMS User Guide.

The CD-ROM is expected to be completed by midsummer 2000 (in time for the Quadrennial Ozone Symposium in Sapporo, Japan) and will be distributed to the public by the GES DAAC.

ATMOSPHERIC DYNAMICS

3-D dynamic and thermodynamic state of the Earth-atmosphere system, from satellite measurements and assimilation systems.

New Assimilation Data Set

The GES DAAC has begun receiving a new Assimilated Data Set in support of the EOS instruments flown

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aboard the Terra satellite. This suite of products from the GEOS-AM1 (Goddard Earth Observing System for Terra) assimilation system is being produced at Ames Research Center under the direction of GSFC's Data Assimilation Office. The model is currently being run at a spatial resolution of 1° and consists of eight First Look (1-day delay) and thirteen Late Look (2-week delay) products, the latter of which assimilates the largest ensemble of observational data and thus provides for a higher quality product compared to the First Look product. For more details on the contents of these new data products see

http://dao.gsfc.nasa.gov/DAO_docs/filespec/File_Spec_v4.2.html

The GEOS-AM1 data are tentatively scheduled for public release no earlier than August 2000, and more likely at the end of the year, while the DAO continues science quality checkout of the products.

FIELD EXPERIMENTS

Aircraft and ground based measurements of meteorological variables designed to improve science algorithms and validate satellite-derived data products.

SGP99 Web Site

The Southern Great Plains 1999 (SGP99) Web site has been activated at the GES DAAC at

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/SGP99/index.html

This experiment, which took place in Oklahoma during July 1999, was a follow-on to the successful SGP97 campaign designed to gain a better understanding of soil moisture and temperature characteristics using both traditional ground based measurements and remotely sensed microwave measurements flown aboard several aircraft. Ground based data sets are currently available from the site, with plans to include satellite (e.g., Landsat, SSM/I, and TRMM), aircraft (C-130, P3-B), and regional network data (e.g., Oklahoma Mesonet, DOE ARM CART) over the next year.

HYDROLOGY

Global precipitation, its variability, and associated latent heating, important for studying the global hydrological cycle, climate modeling, and applications.

TRMM Data's Second Major Reprocessing

The second major reprocessing of the TRMM data products was completed April 30, 2000. All TRMM products have now been updated from Version 4 to Version 5 at the GES DAAC. TRMM data can be searched and ordered at

http://lake.nascom.nasa.gov/data/dataset/TRMM/index.html

South American Real-Time Satellite Rainfall Estimator

Real-time GOES precipitation products (LBA-Hydrology) have been developed and made accessible from the GES DAAC Hydrology Web site at

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/hydrology/satel.realtime.html

The South America rainfall estimate algorithm, that generated these products as part of the GES DAAC LBA project, was improved by the introduction of model-derived precipitable water and relative humidity. This algorithm is currently being transferred from NOAA NESDIS to the GES DAAC.

Goddard DAAC Web Geographical Information System (GIS) Prototype

To promote a wider use of GES DAAC data, especially by the GIS user community, a prototype Web GIS

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/WEBGIS/webgis.html

has been implemented to allow users to preview GES DAAC data and, eventually, carry out some data analysis via Internet browsers. The prototype Web GIS is based on a Java applet that can read shape file GIS data and, from the data, create maps. These maps can be displayed by a Web browser and downloaded in standard GIS (i.e., shape file) and image (i.e., GIF) formats. The longer term goal is to provide GIS data via the GES DAAC Web site in a format compliant with the OpenGIS standards. This GIS Web page can also be reached from the Hydrology Home Page.

TRMM Field Experiments

Members of the Hydrology Data Support Team prepared for the TRMM Field Experiment (FE) Workshop that took place in Salt Lake City, May 22–27, 2000. The GES DAAC was tasked to support the archive and distribution of TRMM FE data and the collection of ancillary data sets. A presentation was made on this support effort. FE data from TRMM-LBA and KWAJEX received from the experiment PIs are being incorporated into the TRMM FE Web sites. A "TRMM FE Data Collection Overview" Web page, which provides an alternate means (view) to access FE data and information, was finalized in time for the FE Workshop.

INTERDISCIPLINARY

Global land, ocean, & atmospheric parameters mapped to uniform spatial and temporal scales for basic research and applications studies.

Nothing to report at this time.

LAND BIOSPHERE

Long time-series vegetation and thermal infrared brightness temperature data sets for global change research.

Reformatted Version of the Pathfinder Land 8 km Data

Ingest of the reformatted version of the Pathfinder Land AVHRR 8 km data is almost complete. The original global, multiparameter HDF data files have been reformatted into separate parameter files that have been spatially subset into 1000 km tile areas. Daily time series files for each parameter tile have been constructed for the 1981–1994 data period (5000 days). Work began on applying corrections to the raw tile data to make it consistent with our 10-day data products. A point and

click interface was developed to allow users to order these data through our standard distribution system. We anticipate releasing these data to the public by midsummer this year.

AVHRR Pathfinder Data Production

Renormalization of the 1995–1999 10-day data has been completed and a revised version of this data set is available in HDF format in our near-online tape archive and as binary formatted products on our FTP site. We are now processing year 2000 data close to real time and are making these products available to the public within 1 to 2 weeks of real time.

MODIS DATA SUPPORT

Radiance data and auxiliary information such as geolocation and cloud mask, atmospheric profiles, and higher level ocean color data.

Preliminary Data Products Are Now Available

Calibrated and geolocated (Level 1B) sensor radiances are now available to the general public together with the raw measurements and the engineering and onboard calibration data used to characterize the sensor behavior. ALERT! — this release of the MODIS Level 1B format values is an early beta version. It is intended primarily for use by researchers evaluating product format for Level 2 and higher science products and for testing algorithms. The sensor operational configuration is not finalized, and changes to detector biases, lookup table parameters, etc., may be changed without warning as we seek to optimize the overall sensor performance. Changes will be documented in the metadata or on the MODIS Characterization Support Team (MCST) Web page at

http://mcstweb.gsfc.nasa.gov/index.html

It is anticipated that most of these issues will be resolved by July 2000.

Restricted Data

MODIS atmospheric science products are available at the GES DAAC only to registered Science Team members who are evaluating these products. As soon as the team members are satisfied with the calibration and algorithm problems these data products will be released to the public.

Do It Yourself

For those interested and able to receive Direct Broadcast data from the MODIS instrument on the Terra satellite, software is being adapted at the GES DAAC to produce calibrated, geolocated radiances from the Direct Broadcast data. See the MODIS article on p. 6 for further details. Also check the GES DAAC Web site

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/MODIS/index.html

OCEAN COLOR

Remote sensing ocean color data used to investigate ocean productivity, marine optical properties, and the interaction of winds and currents with ocean biology.

SeaWiFS Reprocessing

The GES DAAC was scheduled to begin receiving the latest version of the SeaWiFS data products from the third reprocessing on May 11, 2000. There have been many improvements to the science algorithms that have resulted in correspondingly higher quality geophysical data products. For more details on these improvements please visit

http://seawifs.gsfc.nasa.gov/SEAWIFS/RECAL/Repro3/

New Surface Solar Radiation Data Set

The GES DAAC has recently implemented a new surface solar irradiance (SSI) data set in support of SeaWiFS-related studies. The main purpose is to study the temporal fluctuations of total solar radiation and Phytosynthetically Active Radiation (PAR) on time scales relevant to phytoplankton physiology. These data also provide information on global cloud coverage and cloud optical depth useful as input to radiative transfer models, initialization of global climate models and energy budget studies. The major input data set is the International Satellite Cloud Climatology Project DX data, which are used to produce a 0.5° x 0.5° global gridded product at 3-hour, daily, and monthly time scales. Please refer to

http://daac.gsfc.nasa.gov/data/dataset/SSI/index.html

for more detailed information regarding this data set. This data set was provided to the DAAC by Jim Bishop of the Department of Applied Physics, Columbia University.

For more details about the GES DAAC data holdings and to order data see our Home Page or contact us by e-mail, phone, or fax.

http://daac.gsfc.nasa.gov/

e-mail: daacuso@daac.gsfc.nasa.gov
voice: 301-614-5224
fax: 301-614-5268

GENERAL NEWS

Triana Preparations

The GES DAAC is busily working with the Applied Engineering and Technology Directorate at NASA GSFC and Scripps Institute of Oceanography of the University of California at San Diego in preparation for the Triana launch from the Kennedy Space Center in early 2001. Triana is a mission dedicated to helping scientists construct more accurate models of Earth's climate and providing critical information pertaining to solar radiation effects upon climate. The GES DAAC's role will be to interface with the data production facility at Scripps for the receipt, archive, and distribution of Triana radiance data and geophysical products such as total ozone, aerosol overburden, reflectance, vegetation index, cloud height, water vapor, and surface UV flux. Triana will make these observations from a vantage point 1 million miles away between Earth and the Sun. For further information please see the GSFC Triana Home Page

http://triana.gsfc.nasa.gov/home/

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Meetings & Presentations

The GES DAAC is working to make its data more accessible to the large community of Geographical Information System (GIS) users by putting some of its data in a GIS-compatible format. This program is part of a larger effort by the GES DAAC to build a network of Remote Sensing Information Partners (RSIPs) to help effect a wider distribution and use of NASA remote sensing data. Three initial subsets are being operationally produced from data acquired by the Tropical Rainfall Measuring Mission (TRMM), the Advanced Very High Resolution Radiometer (AVHRR 8 km), and the Geostationary Operational Environmental Satellite (GOES–8). As part of this effort, three GIS talks were presented this spring by Nathan Pollack.

- Web GIS at the Goddard DAAC. Presented at AAG 2000 in Pittsburgh, PA, April 4–8, 2000.
- Expanding the use of GES DAAC remotely sensed data by the GIS community. Presented at the Towson University GIS Conference (TUGIS) in Baltimore, MD, May 1–2, 2000. Coauthors: William Teng, Long Chiu, David Wong, and George Serafino.
- Operational production and distribution of GIS-compatible remotely sensed data to facilitate their use. Presented at ASPRS 2000 annual conference in Washington, DC, May 22–26, 2000. Coauthors: William Teng, Long Chiu, George Serafino, and David Wong.

For more on this GIS initiative, see

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/WEBGIS/webgis.html

Steve Kempler attended a meeting of the Earth Science Information Partners (ESIP) Federation in Houston, January 19–21. He was elected vice-chair of the Products and Services Standing Committee. This committee will decide strategies that will guide various aspects of data dissemination within the federation and future data systems. He was also a copresenter of a talk on widening the federation participation. Additional information on the ESIP Federation is given in the "Partners" article in this issue.

Long Chiu presented "Satellite-based prototype image products for water resource managers in the Middle Rio Grande Basin" at the Fourth Annual U.S. Geological Survey Middle Rio Grande Basin Study Workshop held February 15–16, 2000, in Albuquerque, New Mexico. The paper, coauthored with S. Morain and C. Bales of Earth Data Analysis Center (EDAC) of the University of New Mexico, explores the use of TRMM, AVHRR, and other satellite data in deriving hydrological parameters that may be used in hydrologic models of the region.

Gilberto A. Vicente had a poster presentation, "Hydrologic applications of high resolution geostationary satellite rainfall estimates corrected for terrain heights, wind, and parallax—the LBA study," at the American Meteorological Society's 6th International Conference on Southern Hemisphere Meteorology and Oceanography in Santiago, Chile, April 3–7, 2000.

James Acker presented "Ocean Color in Context: Ocean Color Educational Resources at the Goddard Earth Sciences DAAC" on May 2 at the ERIM International Sixth International Conference on Remote Sensing for Marine and Coastal Environments, in Charleston, SC.

Two Papers were presented at the American Geophysical Union Spring 2000 Meeting (May 30–June 3, 2000) in Washington, DC. **Suhung Shen** presented "Ocean color data and information system at the Goddard Earth Sciences (GES) DAAC." Coauthors: J.G. Acker, Y. Wang, R. Simmon, G. Leptoukh, and G. Serafino. Briefly, MODIS ocean color data will soon be added to the SeaWiFS and CZCS ocean color data sets already available from the GES DAAC. A fully automated system was designed and developed at the GES DAAC to meet the mission requirements. This system includes the data ingest and archive system, the standard order system (subscriptions) and a WWW interface (online ordering system). Ocean color data can be accessed through the GES DAAC home page,

http://daac.gsfc.nasa.gov/

Robin G. Williams presented "Goddard Space Flight Center Earth Sciences DAAC data services for MODIS ocean and atmosphere data." Coauthors: J.V. Koziana, G.G. Leptoukh, G.N. Serafino, and A.K. Sharma. The paper describes the innovative archiving and distribution techniques developed by the GES DAAC to handle the 0.5 terabytes delivered daily to the GES DAAC by the MODIS team.

DATA HANDLED IN GIGABYTES DURING 1999

Almost all the ingested data and most of the data distributed by ftp and media refer to compressed data sets. The uncompressed data volumes would be two to three times larger. No MODIS data handling statistics are included in this table.

	INGESTED			DISTRIBUTED			
Month	TRMM	Other	Total	ftp	Media	CDs	Total
JAN	604.9	61.7	668	345.5	1444.3	3615.9	5406
FEB	614.9	52.0	667	363.4	1468.5	7030.4	8862
MAR	571.8	86.2	658	304.8	2591.0	5736.2	8632
APR	347.7	58.2	406	478.4	1927.2	4827.7	7233
MAY	371.9	158.5	530	336.0	1139.4	4184.3	5660
JUN	242.7	125.0	368	259.0	2288.5	2476.5	5024
JUL	249.0	80.4	329	382.2	1362.0	2531.0	4275
AUG	279.7	130.5	410	599.6	2759.4	1680.9	5040
SEP	251.0	81.8	332	357.5	2472.9	606.7	3437
OCT	238.2	111.8	350	246.6	1267.4	1125.7	2640
NOV	290.6	105.2	396	396.4	3409.3	7.3	3813
DEC	807.7	74.0	882	562.2	2232.6	0.0	2795
JAN	947.4	288.0	1236	533.3	2613.0	53.0	3199
FEB	1078.6	177.5	1256	820.0	4760.3	93.9	5674
MAR	233.2	130.6	1364	783.4	2915.8	7.2	3706
APR	888.9	128.6	1018	1035.1	2892.2	53.0	3980

PEOPLE IN THE NEWS

Our personality for this issue is James Acker, the Lead of the Ocean Color Data Support Team. He writes,

"I grew up in a suburb of Chicago and attended college one state to the north, at Lawrence University of Wisconsin. I received a bachelor's degree in chemistry and was two courses short of a double major in English. Then, encouraged by a Lawrence alumnus, who was at the University of South Florida (USF), I entered a unique straight-to-Ph.D. program in marine science at USF's marine science department in St. Petersburg. It was a nice honor, but it's a significant study incentive when you realize that if you don't pass your Ph.D. candidacy exams, you've wasted 5 years of graduate school. I managed to pass, and I was able in the course of my research to see a lot of water on three major cruises: Kwajalein Atoll to Dutch Harbor (AK) to Seattle in 1982, La Reunion to Crozet to Kerguelen to Ile Amsterdam (Indian Ocean) in February 1985, and Honolulu to Kodiak Island (AK) in summer 1985. My research investigated the dissolution kinetics of the calcium carbonate shells of aggravating little zooplankters called pteropods—aggravating because their escape behavior is to sink, which makes it difficult to determine how important they are in the oceanic carbon cycle. But this problem has led me to a small corner of the research world that I hope will result in a journal paper later this year. More on that later.

"When I finished graduate school, I did a 2-year postdoc with USGS in Reston, VA, investigating acid rain-mineral interactions. Then I tried a year in the field with USGS in Baltimore doing watershed geochemistry. I accidentally found the position of Earth Observing System Oceanographic Liaison at Goddard in 1990, and so I came here. The position allowed me considerable freedom to learn about NASA's ocean remote sensing programs, and I met numerous ocean scientists at several different institutions. As the EOS budget tightened, I transferred over to the SeaWiFS project, writing several Technical Memoranda using the powerful user hostile typesetting package TeX. I escaped TeX and did some Web work for the Laboratory for Hydrospheric Processes before coming to the DAAC a year before SeaWiFS launched. Since then, I've become familiar with the data base, I've established relationships with numerous ocean color users around the world (it helps that they have to come to us for a user name and password), and I've also been able to expand some of our informational resources, which allows me to enjoy writing. Recently, I was approached by the Alliance for Marine Remote Sensing, which publishes *Backscatter* magazine, to write a 'column' for them about news in the ocean color science community. We call the column Ocean Color Spectrum.

"About that research: because pteropods are hard to quantify, when I started looking at the carbon cycle, another unknown is the amount of carbonate sediment that is transported from shallow carbonate banks, like the Bahamas Banks. Researchers are still unsure of the major mode of transport, whether it's a continual slow 'rain,' or episodic events, either storms or other unusual weather conditions. I came up with the idea that remote sensing, particularly SeaWiFS, could see major transport events. Hurricane Floyd's effects on the Bahamas, and Hurricane Gert's winds on Bermuda, provided some excellent

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demonstrations of the concept, and allowed a better idea of exactly what can be seen from space. So I'm turning those observations into a paper. I'm also writing a paper about the SeaWiFS data system, which will be completed after the third SeaWiFS data reprocessing is done. This next reprocessing will be challenging, as we want to do it at a very high rate and it also includes new data products, requiring much of the documentation to be revised.

"On the personal side, I married my wife Dorothy in 1993. After she entered a nursing program and finished her nursing degree, we expanded our family in a hurry this year by having twins, Audrey Frances and Benjamin Pierce, in late October, and then finalizing the adoption of Natalie Renee from China in late November! These events have turned our home into the proverbial three-ring circus, but with the able assistance of my mother-in-law, we've kept the babies healthy and happy and the adults are all still conscious."

Congratulations to Hualan Rui on her appointment as the new leader of the Hydrology Data Support Team (HDST). Bill Teng wrote

"It is with great excitement and pleasure that we announce that Ms. Hualan Rui will be assuming the position of Hydrology DST Lead, effective May 15, 2000. Ms. Rui has been a member of the HDST since 1997, when she joined the GES DAAC. During this time she has made many fundamental contributions to the successful HDST support of the Tropical Rainfall Measuring Mission, as well as being an invaluable resource for the GES DAAC in general. In addition to her strong science background (in atmospheric science), Ms. Rui has a very strong computer science background and is extremely knowledgeable about the GES DAAC infrastructure. Congratulations to Ms. Rui for this promotion to her new appointment. I am sure that everyone will give her their full support, as she assumes the responsibilities of this new position.

"The HDST Lead is a role that I have been in since 1996, and, for the past year or so, together with that of the Science Lead (for the Customer Service Data Support Group and the Science Software Integration and Test Group at the GES DAAC). With this transfer of the HDST Lead position to Ms. Rui, I will be able to focus more on the Science Lead duties, which are growing, as the GES DAAC gets increasingly involved in new missions and new technology. To effect a smooth transfer of responsibilities, Ms. Rui and I will do the 'hand off' over a transitional period. At least through this period, I expect to remain an active member of the HDST."

The Global Scanner is a publication of NASA's Goddard Space Flight Center Earth Sciences (GES) Distributed Active Archive Center (DAAC).
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Goddard Space Flight Center Center
Earth Science Distributed Active Archive Center
Code 902
NASA Goddard Space Flight Center
Greenbelt, MD 20771